

METHANOL IN THE SKY WITH DIAMONDS; L.J. Allamandola, S.A. Sandford, A.G.G.M. Tielens, NASA/Ames Research Center, MS 245-6, Moffett Field, CA 94035, and T. Herbst, Univ. of Hawaii, Institute for Astronomy, 2680 Woodlawn Dr., Honolulu, HI 96822

The presence of gas phase methanol (CH_3OH) in dense interstellar molecular clouds was established by the radio detection of its rotational emission lines (1). The presence of solid state methanol in these clouds had not been as rigorously demonstrated (2). However, the position, width, and profile of an absorption band near 1470 cm^{-1} ($6.8\text{ }\mu\text{m}$) in the infrared spectra of many dense molecular clouds strongly suggests that solid methanol is an important component of interstellar ices. This identification of the 1470 cm^{-1} ($6.8\text{ }\mu\text{m}$) band is not unique, however, and other identifications of the feature have been suggested (3). In an attempt to better constrain the identification of the 1470 cm^{-1} ($6.8\text{ }\mu\text{m}$) feature we began a program to search for other characteristic absorption bands of solid state methanol in the spectra of objects known to produce the 1470 cm^{-1} ($6.8\text{ }\mu\text{m}$) band. One such feature has now been unambiguously identified in the spectra of several dense molecular clouds and its position, width, and profile fit well with those of laboratory $\text{H}_2\text{O}:\text{CH}_3\text{OH}$ ices. Thus, the presence of methanol-bearing ices in space is confirmed.

In all the spectra in which the new methanol band was detected, and in several spectra in which the feature was not detected, a second, unexpected band was discovered. After consideration of the position, width, and profile of the new band we tentatively identify micro-diamonds to be the source material causing the new absorption feature. The identification of the absorption feature with micro-diamonds is supported by comparisons with spectra from vapor-condensed micro-diamonds studied in the laboratory. There are indications that this material is ubiquitous in space and it is therefore likely to be related to the meteoritic diamonds that carry interstellar signatures (4).

The abundances of these two important C-bearing materials, the implications of their detection in space, and the relationship of these diamonds to those identified in meteorites will be discussed in further detail in the talk.

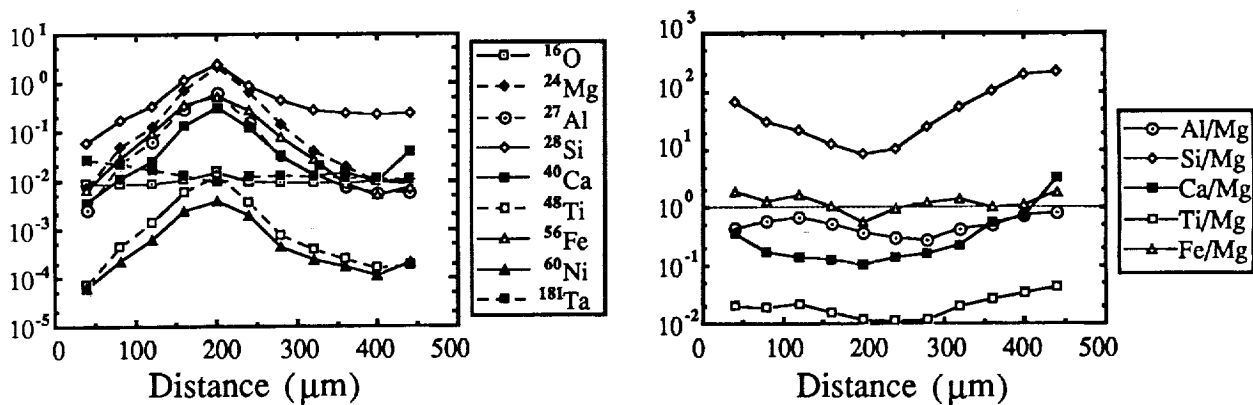
References:

- (1) cf. Irvine, W.M., Goldsmith, D.F., and Hjalmarsen, A. (1987), in Interstellar Processes, eds. D. Hollenbach and H. Thronson, D. Reidel, 561-609.
- (2) Allamandola, L.J. (1984), in Galactic and Extragalactic Infrared Spectroscopy, eds. M.F. Kessler and J.P. Phillips, Reidel, 5-35.
- (3) Tielens, A.G.G.M. and Allamandola, L.J. (1987), in Physical Processes in Interstellar Clouds, eds. G. Morfil and M. Scholer, Reidel, 333-376.
- (4) Lewis, R.S., Tang, M., Wacker, J.F., Anders, E., and Steel, E. (1987), Nature 326, 160-162.

SIMS ANALYSIS OF MICROMETEOROID IMPACTS ON LDEF; S. Amari¹, J. Foote¹, E. K. Jessberger², C. Simon¹, F. Stadermann², P. Swan¹, R. M. Walker¹ and E. Zinner¹, ¹McDonnell Center for the Space Sciences and Physics Dept., Washington University, One Brookings Drive, St. Louis, MO 63132, ²Max-Planck-Institut für Kernphysik, Postfach 103980, D6900, Heidelberg, Germany.

LDEF experiment AO187-2 consisted of 237 capture cells, 120 on the leading edge, the rest on the trailing edge. In each cell a 2 μm plastic foil, metallized on both sides, covered polished Ge targets. Although all plastic covers except for 12 cells on the trailing edge failed during flight, the Ge plates contain many extended impact features that were apparently produced by projectile material that had penetrated the plastic foils while they were still intact. We optically scanned all cells without plastic foil from the trailing edge and found extended impact features from 200 to 4000 μm in diameter with 4 characteristic morphologies: a. craters surrounded by deposits, b. ring-shaped features, c. sprays, and d. "spider webs." 53 impacts were selected as high priority candidates for ion probe analysis. After detailed documentation in the SEM impacts were analyzed in the ion microprobe for the chemical composition of the remaining projectile material. Prior simulation studies [1] had shown that extended impact on the Ge plates contained sufficient projectile material for chemical and isotopic analysis by SIMS. We made multi-element point analyses in lateral scans across the impact features. Each point analysis consisted of depth profiles of a number of elements. In all of 12 impacts so far studied we found evidence for the presence of projectile material in the form of elemental enhancements in the impact region, in 5 cases significant amounts of projectile material were detected. One such analysis is shown in Figs. 1 and 2. Fig. 1 shows ion signals of different isotopes normalized to the ^{76}Ge signal for a scan across a "spider web" impact. In Fig. 2 the selected signals of ^{27}Al , ^{28}Si , ^{40}Ca , ^{48}Ti and ^{56}Fe were normalized with relative sensitivity factors determined from laboratory studies [1] to obtain elemental abundance ratios relative to Mg. Their abundances indicate an extraterrestrial origin except for Si, which is anomalously high and is probably dominated by contamination from RTV glue used to bond the Ge plates to the Al substrate. Enough material is present to allow isotopic measurements, which will be reported at the meeting.

[1] Lange G. *et al.* (1986) *Lunar Planet. Sci. XVII*, 456.

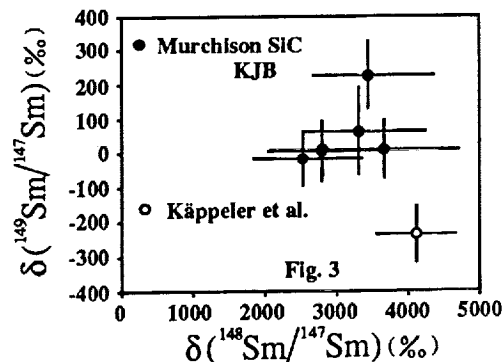
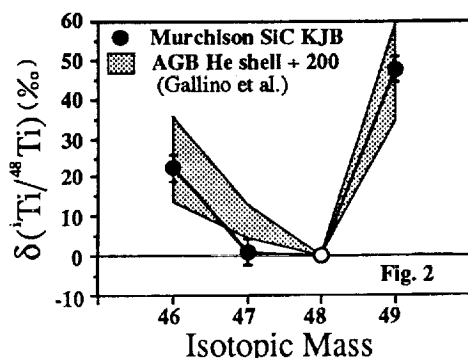
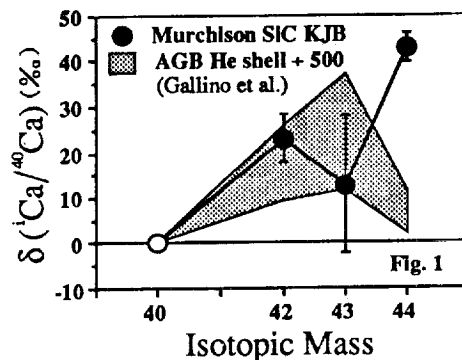


Ca, Ti AND Sm ISOTOPIC COMPOSITIONS OF FINE-GRAINED INTERSTELLAR SiC; S. Amari^{1,2}, E. Zinner¹ and R. Lewis², ¹McDonnell Center for the Space Sciences and the Physics Dept., Washington University, One Brookings Drive, Saint Louis, MO 63130-4899 USA, ² Enrico Fermi Institute, University of Chicago, 5630 S. Ellis Ave., Chicago, IL 60637-1433 USA.

We have extended ion probe isotopic measurements in fine-grained aggregates (\equiv "bulk") of SiC from C, N, Si, Mg, Ba and Nd [1, 2] to Ca, Ti, Cr, Fe and Sm. Measurements were made on grain size fraction KJB (nominal size 0.1-0.2 μ m) from the Murchison carbonaceous chondrite [3]. We used high mass resolving power for all elements except Sm which was analyzed (together with Ba and Nd) under energy filtering conditions. The results for Ca and Ti shown in Figs. 1 and 2 are averages of 16 measurements on different aggregates. The Ti pattern agrees better with the predictions for the He-burning shell of AGB stars [4] than the patterns obtained for large single grains [5]. The AGB model predicts a proportionately (relative to ^{42}Ca and ^{43}Ca) much smaller ^{44}Ca excess than what is actually observed (Fig. 2). This excess is probably due to the presence of rare exotic (\equiv X) SiC grains carrying large ^{44}Ca excesses [6] due to the decay of ^{44}Ti ($t_{1/2} = 47$ years). This is indicated by large variations (from 20‰ to 160‰) of the ^{44}Ca excesses for different measurements, similar to the large variations of $^{26}\text{Al}/^{27}\text{Al}$ (grains X have a ratio of ~ 0.2 [6]) previously seen in "bulk" measurements of different grain size fractions [1]. The $^{53}\text{Cr}/^{52}\text{Cr}$ and $^{54}\text{Fe}/^{56}\text{Fe}$ ratios are normal within measurement errors. However, the concentrations of Ca and Fe are surprisingly high and it is likely that these two elements reside not in SiC but in other phases such as chromium spinels.

The isotopic measurements of Sm are complicated by the presence of isobaric interferences from Nd and Gd. We have measured masses 147, 148 and 149 and corrected for ^{148}Nd (a pure r-process nuclide). This cannot be done exactly since we do not know the composition of pure s-process Nd. An estimate was made by measuring the $^{135}\text{Ba}/^{136}\text{Ba}$ ratio and assuming the same s-process to normal mixing ratio for Ba and Nd. The Sm ratios are plotted in Fig. 3 with errors for $^{148}\text{Sm}/^{147}\text{Sm}$ that reflect the extremes of the estimated s-process Nd composition. They display an s-process signature, similar to Ba and Nd, which agrees reasonably well with theoretical predictions [7].

References: [1] Amari *et al.* (1991) *Lunar Planet. Sci.* XXII, 19; [2] Zinner *et al.* (1991) *Lunar Planet. Sci.* XXII, 1553; [3] Lewis *et al.* (1990) *Nature* 348, 293; [4] Gallino *et al.* (1991) personal communication; [5] Ireland *et al.* (1991) *Ap. J. (Lett)*, in press; [6] Zinner *et al.* (1991) this volume; [7] Käppeler *et al.* (1989) *Rep. Prog. Phys.* 52, 945.



RENAZZO-LIKE CHONDRITES; A LIGHT ELEMENT STABLE ISOTOPE STUDY; R.D. Ash, M.M. Grady, A.D. Morse and C.T. Pillinger, Planetary Science Unit, Dept. of Earth Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, England.

Several meteorites from the Western Saharan desert have been likened, upon petrologic grounds, to the carbonaceous chondrite Renazzo. Renazzo has distinctive light element stable isotope signatures, with enrichments in deuterium and heavy nitrogen (1,2). Stepped combustion of the meteorite shows that the release profile of the carbon and the composition of its component parts are also quite unusual, although the bulk carbon isotopic signature is quite typical for carbonaceous chondrites. EET 87770, another CR, has similar isotopic properties, deuterium and ^{15}N enrichment (3).

The examined Saharan meteorites, a single find - El Djouf - and three specimens, found 500km to the north east, in close proximity to each other (Acfer 59, Acfer 139 and Acfer 186) were analysed to determine their carbon, nitrogen and hydrogen contents and isotopic compositions, along with Renazzo and EET 87770 for comparison.

The nitrogen stepped combustion analysis of El Djouf is very similar to that of EET 87770, with two yield maxima, between 400° and 600°C and between 650° and 900°C with a $\delta^{15}\text{N}$ between +120 and +180‰. Above 1000°C the $\delta^{15}\text{N}$ drops sharply, reaching minima of +22‰ in EET 87770 and -213‰ in El Djouf. This component, absent from Renazzo, may be due to presolar SiC which is ^{14}N enriched (4). Such a light $\delta^{15}\text{N}$ in a whole rock sample implies that it is present in unprecedented concentrations. The three Acfer 'CRs', analysed by single step combustion, showed lower $\delta^{15}\text{N}$ values than the other CRs, lying between +65‰ and +103‰ compared with El Djouf (+119‰) and Renazzo and EET 87770 (+163 and +158‰ respectively).

The carbon isotopic compositions of the meteorites lie within the field of all carbonaceous chondrites, with $\delta^{13}\text{C}$ values between -5.0 and -12‰. Stepped combustion analysis may give more unequivocal results, with Renazzo showing three distinct isotopic peaks, including a heavy carbon component (+40‰) combusting at high temperature.

The D/H signatures of the Saharan meteorites were unlike those of either Renazzo (+547 to +1054‰) or EET 87770 (+1309‰), with El Djouf showing a light isotopic composition (-71 to -159‰) and the Acfer samples a maximum enrichment in deuterium of up to +172‰.

Thus there are several isotopic similarities between the CRs and these desert meteorites, but the D/H ratios differ, whether due primary differences or to isotopic exchange during terrestrial weathering is unclear.

(1) Kolodny *et al.*, (1980) *E.P.S.L.* 46, 149-158. (2) Kung & Clayton (1978) *E.P.S.L.* 38, 421-435. (3) Grady *et al.*, (1991) *L.P.S.C.* XXII, 471-472 (4) Ash *et al.*, (1989) *Meteoritics* 22, 248-249.